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<p>(21) International Application Number: PCT/SE90/00149</p> <p>(22) International Filing Date: 8 March 1990 (08.03.90)</p> <p>(30) Priority data: 8900899-9 14 March 1989 (14.03.89) SE</p> <p>(71) Applicant (<i>for all designated States except US</i>): LOPE MED-ICINE AB [SE/SE]; Dalagatan 35 A, S-113 23 Stockholm (SE).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (<i>for US only</i>): OLSON, Lars [SE/SE]; Apeltunet 7, S-181 48 Lidingö (SE). PERSSON, Håkan [SE/SE]; Vreta Gård, S-147 00 Tumba (SE). EBENDAL, Ted [SE/SE]; Börjegatan 45 B, S-752 29 Uppsala (SE).</p> <p>(74) Agents: HENNINGSSON, Gunnar et al.; Bergling & Sundbergh AB, Box 7645, S-103 94 Stockholm (SE).</p>		<p>(81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.</p> <p>Published <i>With international search report.</i></p>	
<p>(54) Title: PEPTIDES AND ANTIBODIES FOR THE DETECTION OF NGF (NERVE GROWTH FACTOR) AND/OR PRECURSORS THEREOF</p> <p>(57) Abstract</p> <p>A peptide having the formula: Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile, Gly-Asp-Lys-Thr-Thr-Ala-Thr-Asp-Ile-Lys-Gly-Lys-Glu, or functionally equivalent extended or truncated forms thereof excluding native NGF's and precursors thereof; antibodies directed against such peptide; and a process for determining the presence of a mature NGF and/or a precursor thereof in a biological test specimen.</p>			

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Peptides and antibodies for the detection of NGF (nerve growth factor) and/or precursors thereof.

The present invention relates to new peptides, to antibodies directed against said peptides and to diagnostic processes for determining the presence of mature nerve growth factors and precursors thereof.

Nerve growth factor, NGF, is a 118-amino acid protein that acts as a trophic factor for many sensory and sympathetic neurons in the peripheral nervous system and for cholinergic neurons in the brain. Also other non-cholinergic neurons in the central nervous system may be sensitive to NGF. It is therefore of interest to find diagnostic means to determine the presence and the level of NGF and precursors thereof to enable efficient treatment to alleviate different diseases of the nervous system, such as senile dementia of the Alzheimer type, Parkinson's disease, spinal cord injury, stroke, and developmental disturbances.

Accordingly, it is an object of the present invention to provide new peptides which can be efficiently used in such diagnostic procedures.

Another object of the invention is to provide antibodies against such new peptides for use in determining NGF levels using for example enzyme or radioimmuno assays to determine said levels.

Yet another object of the invention is to provide new processes for determining the presence of mature NGF:s and/or precursors thereof.

For these and other purposes the present invention provides for a peptide having the formula:

Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile,

Gly-Asp-Lys-Thr-Thr-Ala-Thr-Asp-Ile-Lys-Gly-Lys-Glu.

One preferred peptide has the following formula:

Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile, said peptide corresponding to amino acid residues -103 to -90 in the human NGF precursor. The antibodies to this peptide

are effective in detecting the NGF precursor and can be used in immunological determination of the NGF precursor protein.

Another peptide according to the invention has the formula:

5 Gly-Asp-Lys-Thr-Thr-Ala-Thr-Asp-Ile-Lys-Gly-Lys-Glu, and this peptide corresponds to the conserved region of the NGF protein corresponding to amino acid residues 23 to 35 of the mature NGF protein. Tests performed in connection with the research leading to the present invention demonstrate recognition of the native NGF protein by antibodies raised to this peptide.

10 Relevant antibodies can be directed either against any of the peptides described above or both such peptides and native NGF:s. The antibodies may be either polyclonals or 15 monoclonals.

20 The invention also provides for a process for determining the presence of mature NGF or a precursor thereof in a biological test specimen. Said process is based on the interaction between antibodies generated by immunization using a peptide according to the invention and said NGF or said precursor. Such determination may be qualitative or quantitative depending on the type of diagnosis performed and the object 25 of the assay.

The test specimen subject to such assay may be constituted by mammalian brain tissue, such as brain tissue of human origin.

In the present disclosure, when reference is made to living animal body or living mammal body said terms are intended to include also man.

30 The present invention will be further illustrated below with reference to the appended drawings, wherein:

Fig. 1A shows homologous antibody binding to NGF peptides as a function of antiserum concentration;

35 Fig. 1B shows binding of affinity-purified peptide antibodies to their homologous peptides as a function of concentration of the immunoglobulines (Ig);

Fig. 1C shows antibody binding to different NGF-peptides shown as a function of antiserum concentration;

Fig. 2A shows peptide antibody binding to the β -NGF protein as a function of concentration of the affinity-purified immunoglobulines;

Fig. 2B shows comparison of binding to NGF peptide P3 in different antisera to β -NGF; and

Fig. 2C shows antibody binding to different synthetic NGF peptides by an antiserum to mouse β -NGF.

10

EXAMPLE 1

Synthesis of NGF Peptides

Hydrophilic areas suggested by the hydrophilicity values of Hopp TP, Woods KR (1981): Prediction of protein antigenic determinants from amino acid sequences. Proc. Natl. Acad. Sci. (USA) 78:3824-3828 in the pro-NGF and the mature NGF were selected for peptide synthesis (Table I). Peptides P1 to P6 were synthesized by Cambridge Research Biochemicals Ltd., England, at an estimated purity of greater than 80% and checked by amino-acid analysis, HPLC and mass spectrometry. Peptides P7 and P8 were kindly synthesized by Drs. Tamas Bartfai and Janis Abens at the Arrhenius Laboratory, Department of Biochemistry at the University of Stockholm, Sweden. Similarities to any other known protein sequences than NGF for each of these peptides were checked in the GeneBank without any extensive homologies found except to NGF.

EXAMPLE 2

Conjugation and Production of Peptide Antisera

All peptides were conjugated to keyhole limpet hemocyanin (KLH) before use in immunizations. KLH (8-10 mg) was in each case coupled with 3-10 mg of the peptide. Couplings were achieved with m-maleimidobenzoic acid N-hydroxy-succinimide or N-succinimidyl 3-(2-pyridyldithio)propionate to produce N-terminally bound conjugates of P1-P5 and P7-P8 and a C-terminally bound conjugate of P6. After dialysis the pep-

tide-KLH conjugates were used to immunize rabbits (Table II). Each rabbit received an initial dose of about 400 µg of the conjugate in Freund's complete adjuvant intramuscularly as well as via multiple intradermal injections. After 1 month, 5 the rabbits received four weekly booster injections of about 200µg of the conjugate in incomplete adjuvant before being sacrificed.

Purification of Antibodies

10 Affinity columns were prepared for each of the eight peptides; 3 ml of ECH-Sepharose 4B (Pharmacia) was coupled with 2 mg peptide (coupling via a spacer arm to amino groups) using N-ethyl-N-(3-dimethylaminopropyl)-carbodiimide hydrochloride according to the manufacturer's instructions. Each 15 gel was packed in a small column, and antiserum diluted 15-fold in 0.1 M Tris-HCl (pH 8) with 0.5 M NaCl was passed several times over the column. In most cases, the antiserum first had been taken over another column with an unrelated peptide to remove any possible nonspecifically binding components. After washing, the column was eluted with 4.5 M MgCl₂ 20 in 0.05 M NaAc-buffer, pH 5.0, and the peak of eluting antibodies localized by the absorption at 280 nm. The peak was collected, dialysed extensively, and stored frozen.

25 Other Sera Tested

For comparison, normal rabbit antibodies were purified on protein A-Sepharose (rabbit no. 3). Antibodies to mouse β -NGF from rabbit (Ig 17) or sheep (Ig 28) were affinity-purified on NGF coupled to CNBr-activated Sepharose 4B as described earlier (Ebendal T, Olson L, Seiger A (1983): The level 30 of nerve growth factor (NGF) as a function of innervation. Exp Cell Res 148:311-317; Ebendal T, Olson L, Seiger A, Belew M (1984): Nerve growth factors in chick and rat tissue. In Black IB (ed): "Cellular and Molecular Biology of Neuronal Development." New York: Plenum pp 231-242.) In addition, sera 35 from another normal rabbit (no. 19) and from two rabbits im-

munized with mouse β -NGF (nos. 10 and 30) were examined in the present study. Finally, one rabbit (no. 46) receiving the first immunization with β -NGF (200 μ g) and then four boosts with P3-KLH (200 μ g each time) also was included.

5

EXAMPLE 4

Enzyme Immunoassay (ELISA)

10 Ninety-six-well immunoplates were coated with different peptides, KLH or β -NGF (all at 1 μ g/ml) in 0.05 M carbonate buffer (pH 9.6). The plates were blocked with 1% bovine serum albumin (BSA), and then dilutions of the peptide anti-
15 sera or the affinity-purified antibodies were added to the wells and left at 4°C overnight. After extensive washing, bound antibodies were detected with biotinylated antirabbit antibodies (Vector Labs., CA) followed by streptavidin-conjugated β -galactosidase (Bethesda Research Labs., MD). Enzyme activity was examined in a fluorometric plate reader (Dynatech Microfluor) after the addition of methylumbelliferyl- β -galactoside.

20

Bioassay of NGF-Inhibitory Activity

25 NGF activity was demonstrated in an assay with sympathetic chick embryo ganglia explanted to a collagen matrix (Ebendal T, Olson L, Seiger A, Belew M (1984): Nerve growth factors in chick and rat tissue. In Black IB (ed): "Cellular and Molecular Biology of Neuronal Development." New York: Plenum pp 231-242). The influence of increasingly higher antiserum concentrations on NGF-induced fibre outgrowth was determined using this assay.

30

EXAMPLE 5

Immunohistochemistry

35 The NGF peptide antibodies also were characterized immunohistochemically in the salivary glands of adult male mice that had been kept in isolation at least 24 hr prior to sacrifice to ensure a resting state of the salivary glands.

The salivary glands were fixed by perfusion with 4% paraformaldehyde and further fixed by immersion in the same fixative for another 2 hr (Olson L, Ayer-LeLievre C, Ebendal T, Seiger A (1987): Nerve growth factor-like immunoreactivities in rodent salivary glands and testis. *Cell Tissue Res* 248:275-286). Cryostat section (5-14 μ m) were incubated (4°C, overnight) with the affinity-purified peptide antibodies at concentrations 1-20 μ g/ml in phosphate-buffered saline (PBS) with 0.3% Triton X-100. After washing, bound antibodies bound were visualized by incubation for 1 hr at room temperature with fluorescein-isothiocyanate-labelled antirabbit or anti-sheep antibodies. After further rinsing, sections were coverslipped in a mixture of glycerol and PBS (9:1), containing 0.1% p-phenylene diamine as an antifading agent (Johnson GD, de C Nogueira-Araujo GM (1981): A simple method of reducing the fading of immunofluorescence during microscopy. *J Immunol Methods* 43:349-350; Platt JL, Michael AF (1983); Retardation of fading and enhancement of intensity of immunofluorescence by p-phenylenediamine. *J Histochem Cytochem* 31:840-842). Sections were evaluated using epifluorescence microscopy (Nikon MicrophotFX) and the distribution and intensity of fluorescence estimated on a blind basis. Fluorescence intensities were semiquantitatively estimated on a 0-5 scale.

25 RESULTS

Antisera to the eight synthetic NGF peptides were raised in rabbits (Table I) after their conjugation to KLH. All peptide conjugates resulted in antisera that in ELISA tests bound to the appropriate NGF peptide (Table II). Serum titres (fold dilutions) in the ELISA ranged from 1:10,000 to 1:1,000,000. Peptide P2 gave high background values when used to coat the immunoplates and had to be conjugated with bovine serum albumin (BSA) before coating in order to achieve appropriate estimations of the titres of the antisera to P2. The titres measured with KLH-coated wells exceeded the titres for peptide binding and were in the range 1:1,000,000 to

1:10,000,000.

All peptide antisera were subjected to affinity chromatography on columns to which the peptides had been coupled. The recovery of immunoglobulins were in the range 50-200 µg per ml of antiserum (Table II). Recoveries corresponded only to some extent to the relative titres of the different antisera.

Binding to the appropriate NGF peptides by some of the peptide antisera as a function of antiserum dilution is shown in Figure 1A. The antisera bound to coats of the respective peptides at much higher rates than did normal rabbit serum at corresponding concentrations. Some peptide antisera performed better than others, although strict comparisons are not possible, as different peptides may adsorb differentially to the microwells.

Similar results were obtained with the affinity-purified peptide antibodies (Fig. 1B). The signal to KLH-coated immunoplates was at the same time reduced 50- to 500-fold (data not shown). Thus, it was concluded that the applied affinity purification scheme is useful to enhance the specific signal in, e.g., immunohistochemical studies.

The specificity of the peptide antibodies was further examined by ELISA, testing an antiserum raised to one peptide against coats of a range of the synthetic NGF peptides. An example is shown in Figure 1C, from which it is obvious that the homologous combination resulted in the best binding. However, peptides other than the one used for immunization were recognized to some extent (Fig. 1C).

These findings show that antibodies specific to the different synthetic NGF peptides resulted from immunizing the rabbits and that the antibodies could be efficiently purified by affinity chromatography. ELISA then was used to test whether or not any of the peptide antibodies recognized their corresponding peptide sequence in the native β -NGF protein. For comparison, rabbit antibodies (no. 17) to mouse β -NGF was included in the ELISA of NGF-coated immunoplates (Fig. 2A).

Of the peptide antibodies, only Ig 37 and 38, both against peptide P3, bound strongly to the mature β -NGF protein. The signal intensities obtained with these two antibodies were close to that of the affinity-purified, anti-NGF antibody (Fig. 2A). The other peptide antibodies bound NGF at least two orders of magnitude less efficiently, some not above the background levels obtained with normal rabbit immunoglobulin alone. Low levels of binding to native NGF also were found using the precursor-specific peptide antibodies. The findings suggest that peptide P3 is unique in generating antibodies that recognize the mature, native NGF protein.

Whether or not P3 represents an epitope of β -NGF that is found in polyclonal antisera raised to β -NGF also was investigated. Three antisera (AS 10, 17 and 30) were examined in a P3-ELISA, and all recognized the synthetic peptide well above background levels, although they differed in their relative ability to bind to P3 (Fig. 2B). The three NGF antisera bound P3 about one order of magnitude less efficiently than the anti-P3 antiserum AS 38 itself. An antiserum (AS 46) produced by immunization with β -NGF, followed by boosts with P3-KLH, gave the same high binding to P3 coats as the homologous P3 antiserum (Fig. 2B).

In order to check if any of the other peptides would be recognized by NGF antisera, AS 10, 17 and 30 were applied to the entire range of NGF peptides in an ELISA. The peptide P3 consistently resulted in high binding of antibodies (Fig. 2C). AS 17 also bound to P4, but this was less marked with AS 10 and 30. Antiserum AS 46 (the combined NGF/P3 antiserum) also recognized only P3 and none of the other peptides.

The possible interference with NGF activity by the peptide antibodies were studied in a bioassay using explanted sympathetic chick ganglia (Ebendal T, Olson L, Seiger A, Belew M (1984): Nerve growth factors in chick and rat tissue. In Black IB (ed): "Cellular and Molecular Biology of Neuronal Development." New York: Plenum pp 231-242). NGF-induced fibre outgrowths (stimulated by mouse β -NGF) were not blocked by

any of the peptide antisera, not even when present at high concentrations (3%) in the assays (data not shown). Affinity-purified antibodies to peptide P3 also failed to block the outgrowth response (tested at concentrations of up to 8 µg of Ig 38 per ml). This property of the peptide antibodies is reminiscent of the inability of monoclonal antibodies against NGF to block β -NGF-induced fibre responses in the ganglion assay. Furthermore, peptide P3 (at 100 ng/ml) could not substitute for NGF in neurite-outgrowth stimulation, nor did peptide P3 added in vast molar excess interfere with the biological activity of NGF. The NGF antiserum AS 46, at a thousand-fold dilution, was, however, blocking the sympathetic fibre outgrowth evoked by β -NGF.

15 **Immunohistochemistry**

The properties of the peptide antisera and affinity-purified antibodies also were examined using immunohistochemical staining of the male mouse submandibular gland. Various immunoglobulin preparations from the 19 rabbits immunized with the eight different peptides (Table II) were therefore tested immunohistochemically. In several cases, preadsorption tests with appropriate peptides were carried out. In addition, for peptides 4 and 5, the affinitypurified preparations were compared with the excluded fractions from the affinity-purification columns. Finally, comparisons were made to the distribution of immunofluorescence in the salivary gland using affinity-purified anti-NGF-antibodies.

EXAMPLE 6

30 The following peptide:

Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile.
was synthesized by Cambridge Research Biochemicals Ltd., England, at an estimated purity of >80% and checked by amino acid analysis, HPLC and mass spectrometry. The peptide corresponds to position -103 to -90 of the human NGF precursor.

This peptide was subjected to the same treatments and procedures as described in Examples 2 to 5 above giving the same useful results. It was also noted that although the peptide corresponds to a sequence of the human NGF precursor it resulted in good binding of purified peptide antibodies also to NGF precursor of rat origin in spite of differences in protein compositions.

The invention gives the important contribution to the assay techniques in that the levels of both NGF precursor and mature NGF per se can be determined using the peptides of the present invention. This is important in obtaining a correct diagnosis on nerve disorders since the relation between level of precursor and level of mature NGF may be decisive for determining the kind of treatment to be applied. Thus, abnormal levels of mature NGF in a human being can be either caused by overproduction thereof or by reduced consumption thereof. Therefore, the level of precursor can be decisive in establishing the nature of the disorder making it possible to find the correct treatment.

TABLE I
Synthetic NGF and Pro-NGF Peptides*

Peptide			Position	
No	Species	Sequence	Start	End
5	P1 Chicken	(Tyr)-Glu-Thr-Lys-Cys- Arg-Asp-Pro-Arg-Pro-Val- Ser-Ser-Gly-Cys-Arg-Gly	54	69
10	P2 Chicken	Cys-Val-Leu-Ser-Arg-Lys- Ser-Gly-Arg-Pro	109	118
15	P3 Rat(mouse, chicken, human)	(Cys)-Gly-Asp-Lys-Thr-Thr- Ala-Thr-Asp-Ile-Lys-Gly- Lys-Glu	23	35
20	P4 Rat	Cys-Arg-Ala-Pro-Asn-Pro- Val-Glu-Ser-Gly	58	67
25	P5 Rat(mouse)	(Cys)-Glu-Pro-Tyr-Thr- Asp-Ser-Asn-Val-Pro-Glu- Gly-Asp-Ser-Val	-103	-90
30	P6 Rat(mouse, human)	Ser-Pro-Arg-Val-Leu-Phe- Ser-Thr-Gln-Pro-Pro-(Cys)	-38	-28
	P7 Rat	(Lys)-Val-Leu-Ser-Arg-Lys- Ala-Ala-Arg-Arg-Gly	111	120
	P8 Rat	(Cys)-Val-Lys-Ala-Leu-Thr- Thr-Asp-Asp-Lys-Gln-Ala	87	97

*Amino acid residues given within parentheses were added to the NGF sequence for conjugation purposes.

TABLE II
The NGF-Peptide Antisera Studied

Peptide No.	Rabbit AS No.	ELISA titre	Recovery of (μ g/ml)*
5	P1	32 1: 200,000	60
		33 1: 100,000	90
		35 1: 10,000	15
		44 1:1,000,000	70
		48 1: 200,000	120
10	P2	34 1: 10,000	30
		36 1: 100,000	200
15	P3	37 1: 400,000	40
		38 1:1,000,000	80
20	P4	39 1:1,000,000	90
		40 1:1,000,000	100
25	P5	41 1: 100,000	60
		42 1: 10,000	30
30	P6	43 1: 100,000	80
		49 1: 100,000	100
30	P7	45 1: 10,000	150
		50 1: 20,000	90
30	P8	51 1: 200,000	220
		52 1: 100,000	40

*Values refer to recovery of specific peptide antibodies per ml antiserum by affinity chromatography.

CLAIMS

1. A peptide having the formula:

Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile,

5 Gly-Asp-Lys-Thr-Thr-Ala-Thr-Asp-Ile-Lys-Gly-Lys-Glu,

or functionally equivalent extended or truncated forms thereof excluding native NGF:s and precursors thereof.

2. A peptide according to claim 1 having the formula:

10 Glu-Pro-His-Ser-Glu-Ser-Asn-Val-Pro-Ala-Gly-His-Thr-Ile.

3. A peptide according to claim 2 having the formula:

Gly-Asp-Lys-Thr-Thr-Ala-Thr-Asp-Ile-Lys-Gly-Lys-Glu.

4. A peptide according to any preceding claim for diagnostic use in quantitative determination of NGF:s and precursors thereof in a living animal body.

15 5. Antibodies directed against the peptide of any preceding claim.

6. Antibodies according to claim 5 directed against the peptide of claim 2.

20 7. Antibodies according to claim 5 directed against the peptide of claim 3.

8. Antibodies directed against the peptide of any of claims 1 to 4 as well as against native NGF:s.

25 9. Antibodies according to any of claims 5 to 8 which are polyclonals.

10. Antibodies according to any of claims 5 to 8 which are monoclonals.

30 11. A process for determining the presence of a mature NGF and/or a precursor thereof in a biological test specimen using the interaction between the antibodies of any of claims 5 to 10 and said NGF or said precursor.

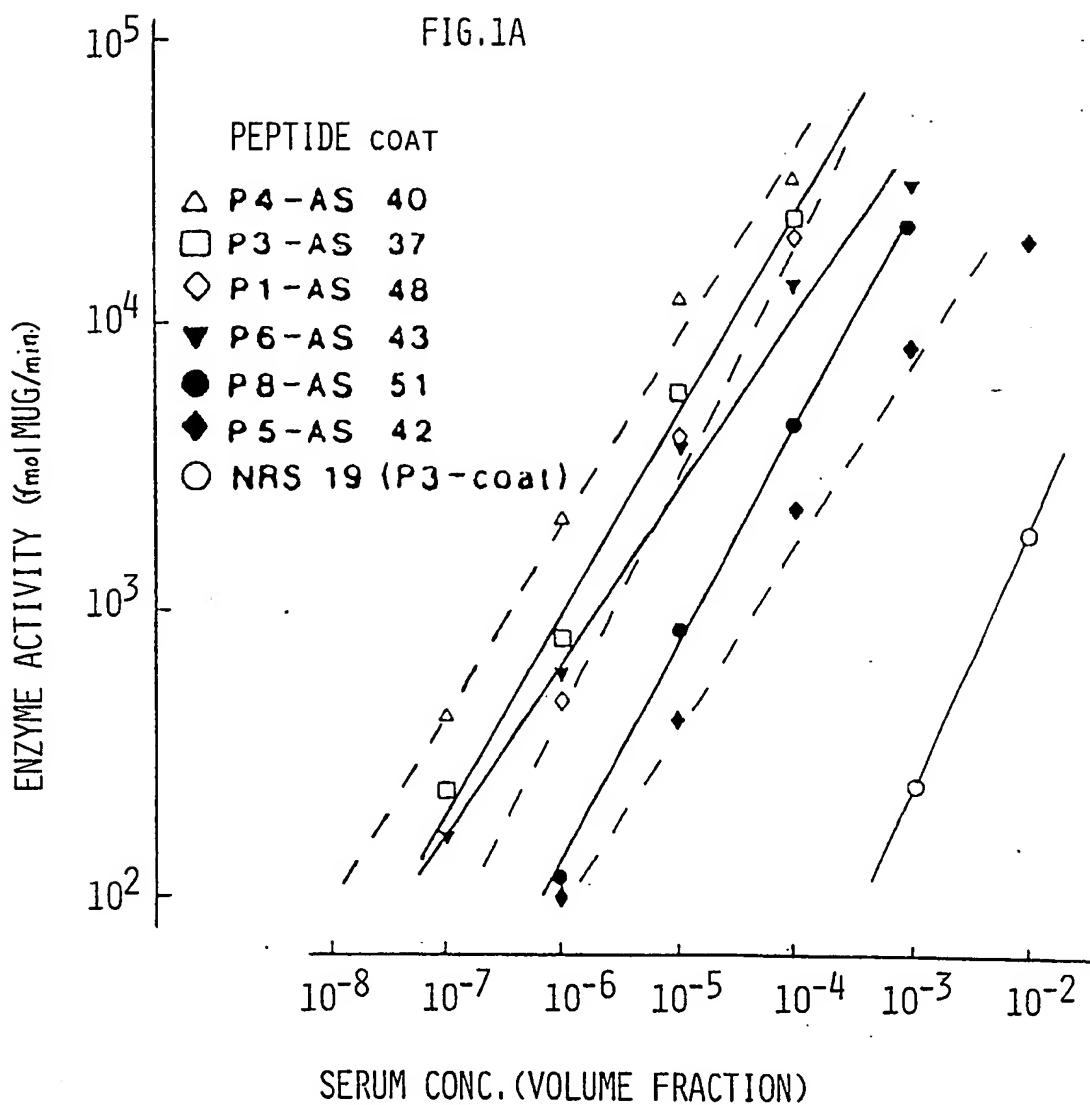
35 12. A process according to claim 11 for quantitative determination of a precursor of a mature NGF in a biological test specimen using the interaction between the antibodies of claim 6, 9 or 10 and said precursor.

13. A process according to claim 11 for quantitative

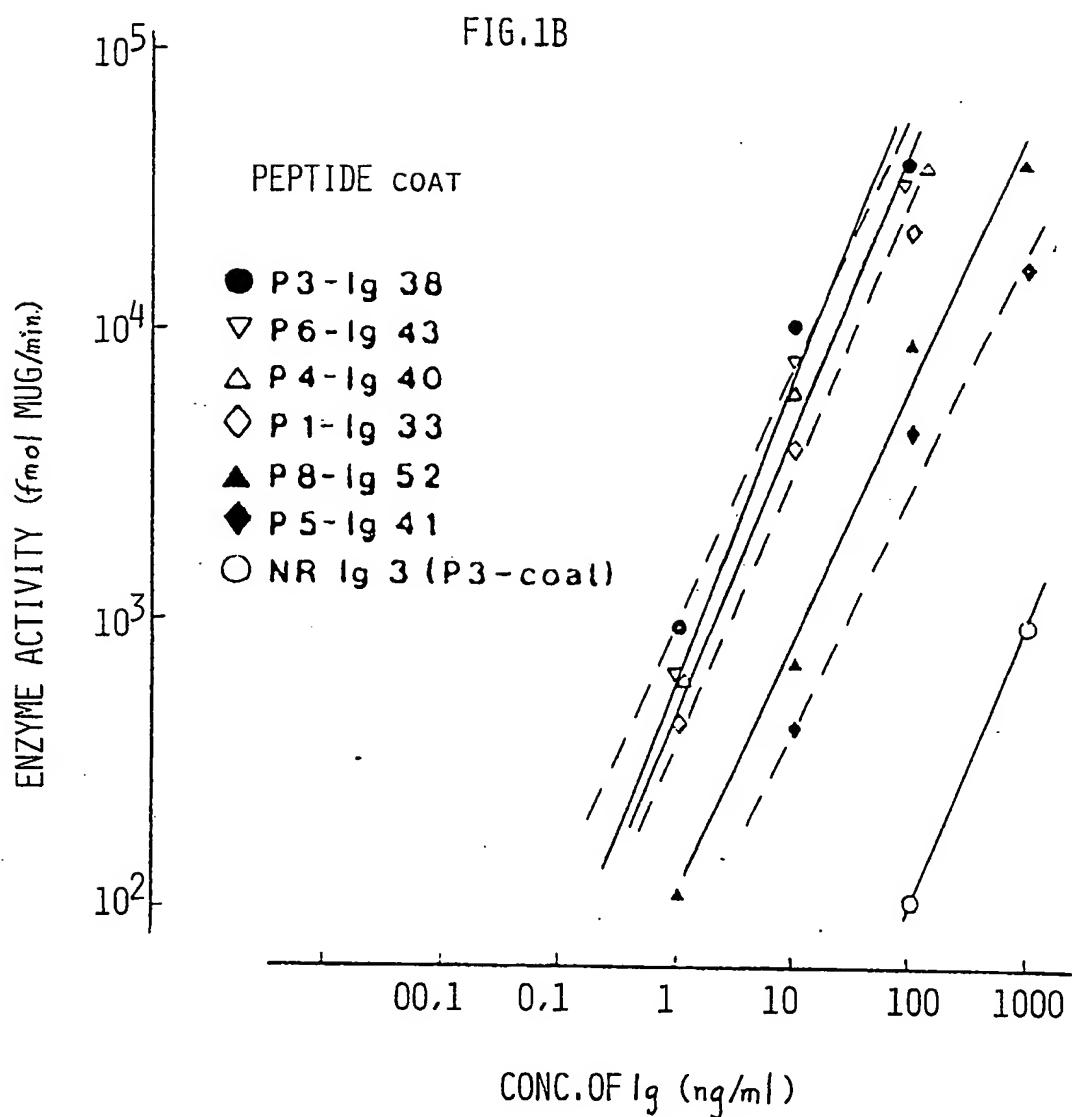
determination of a precursor of a mature NGF in a biological test specimen using the interaction between the antibodies of claim 7, 9 or 10 and said NGF.

14. A process according to any of claims 11 to 13,
5 wherein said test specimen is constituted by mammalian brain tissue.

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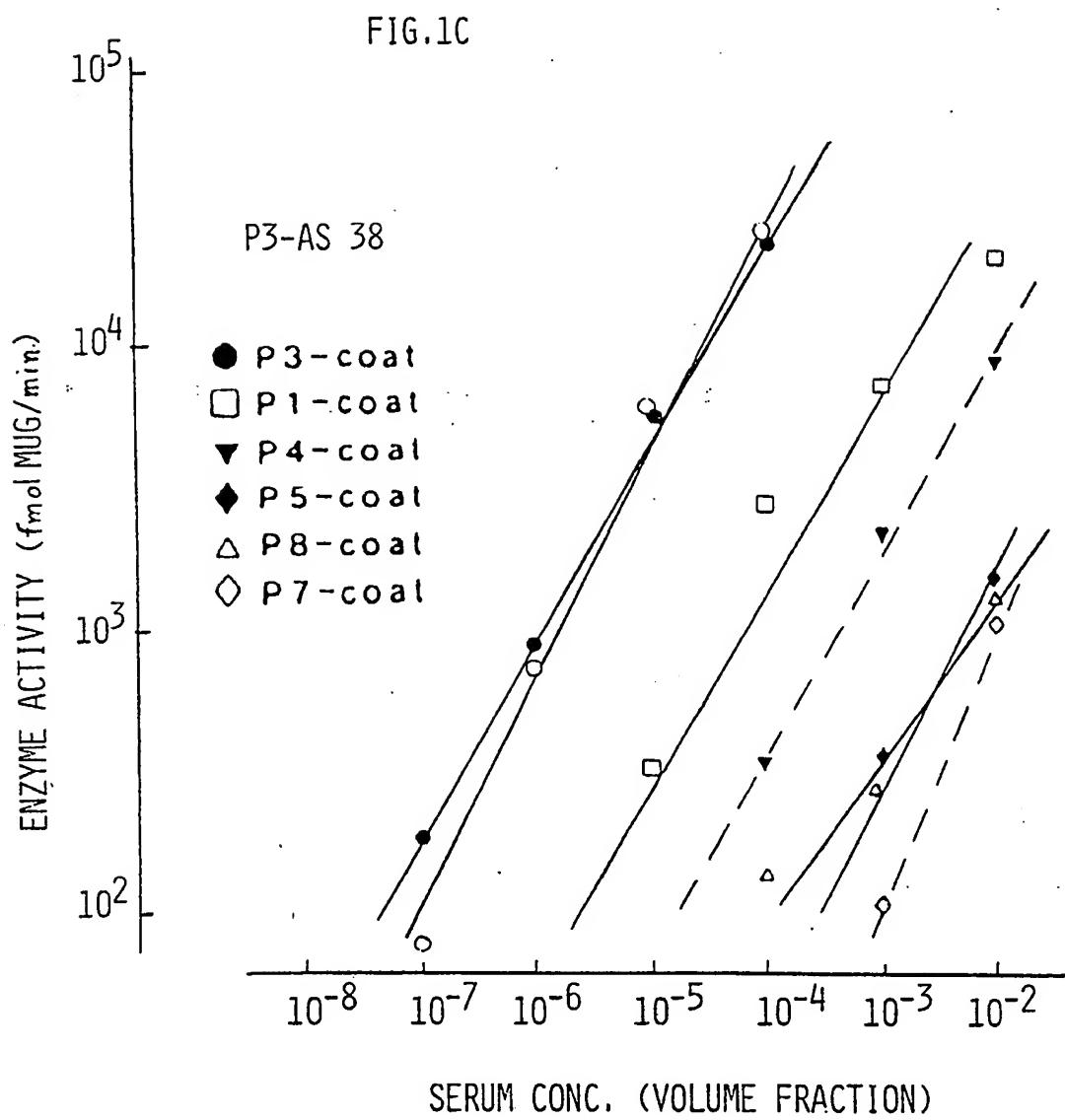
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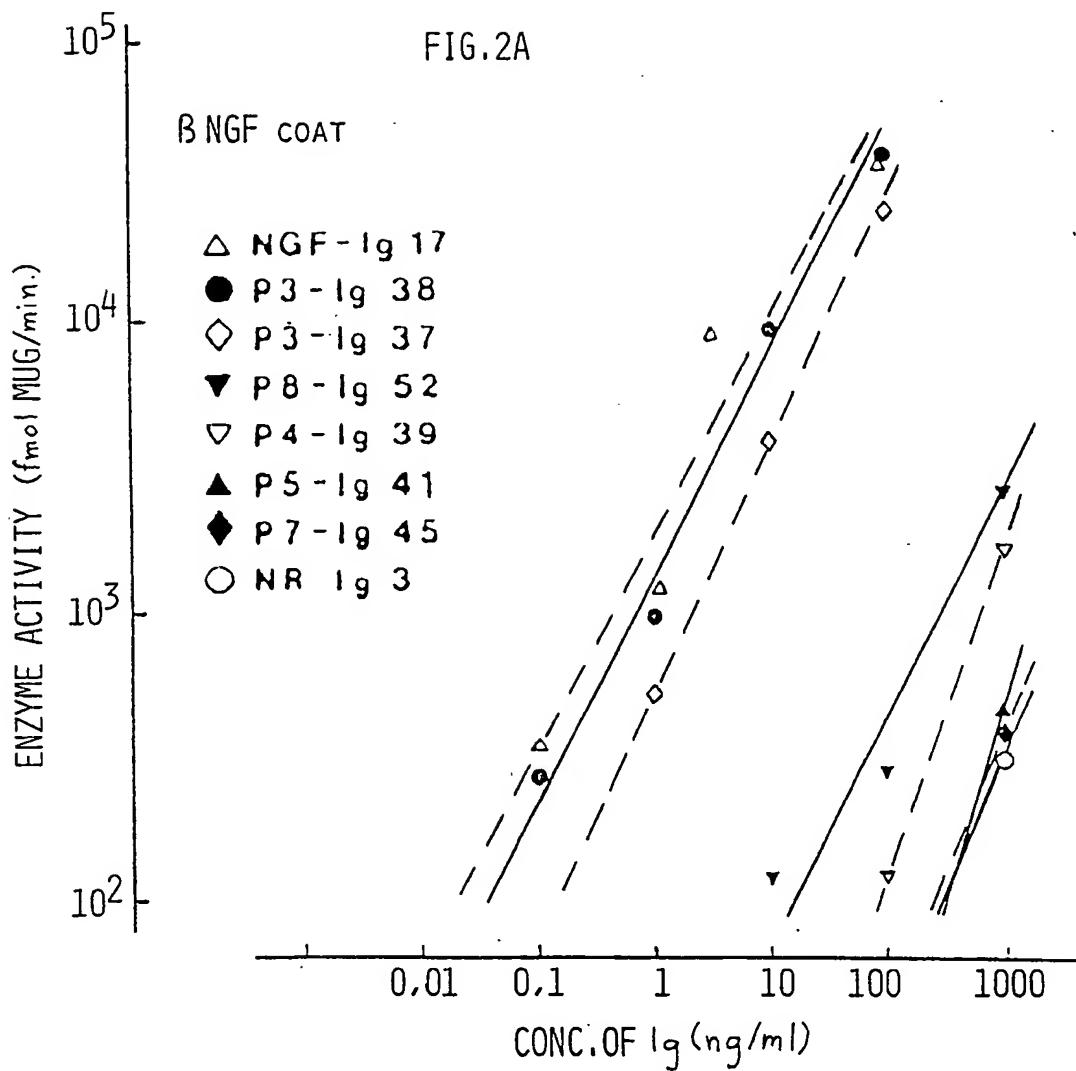


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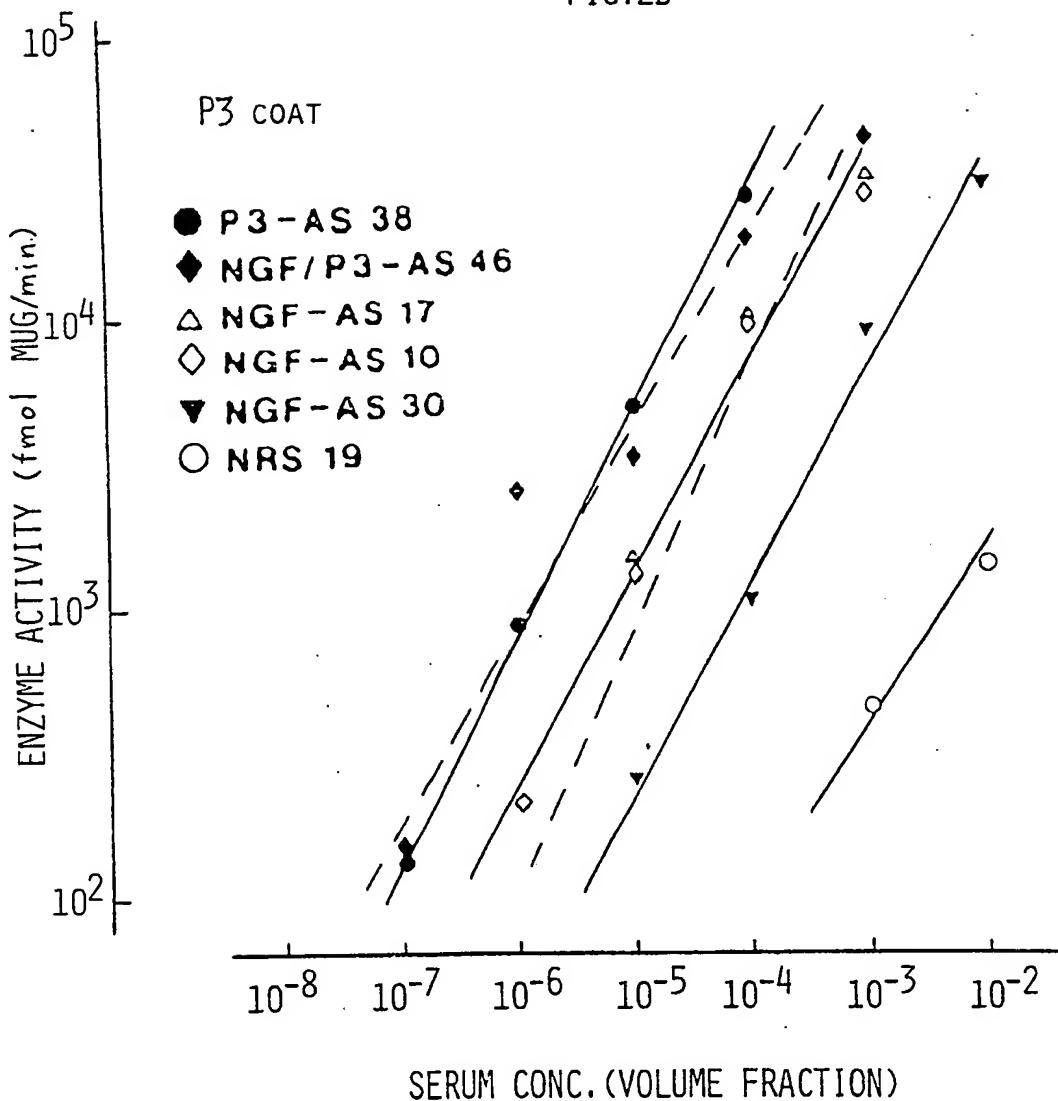
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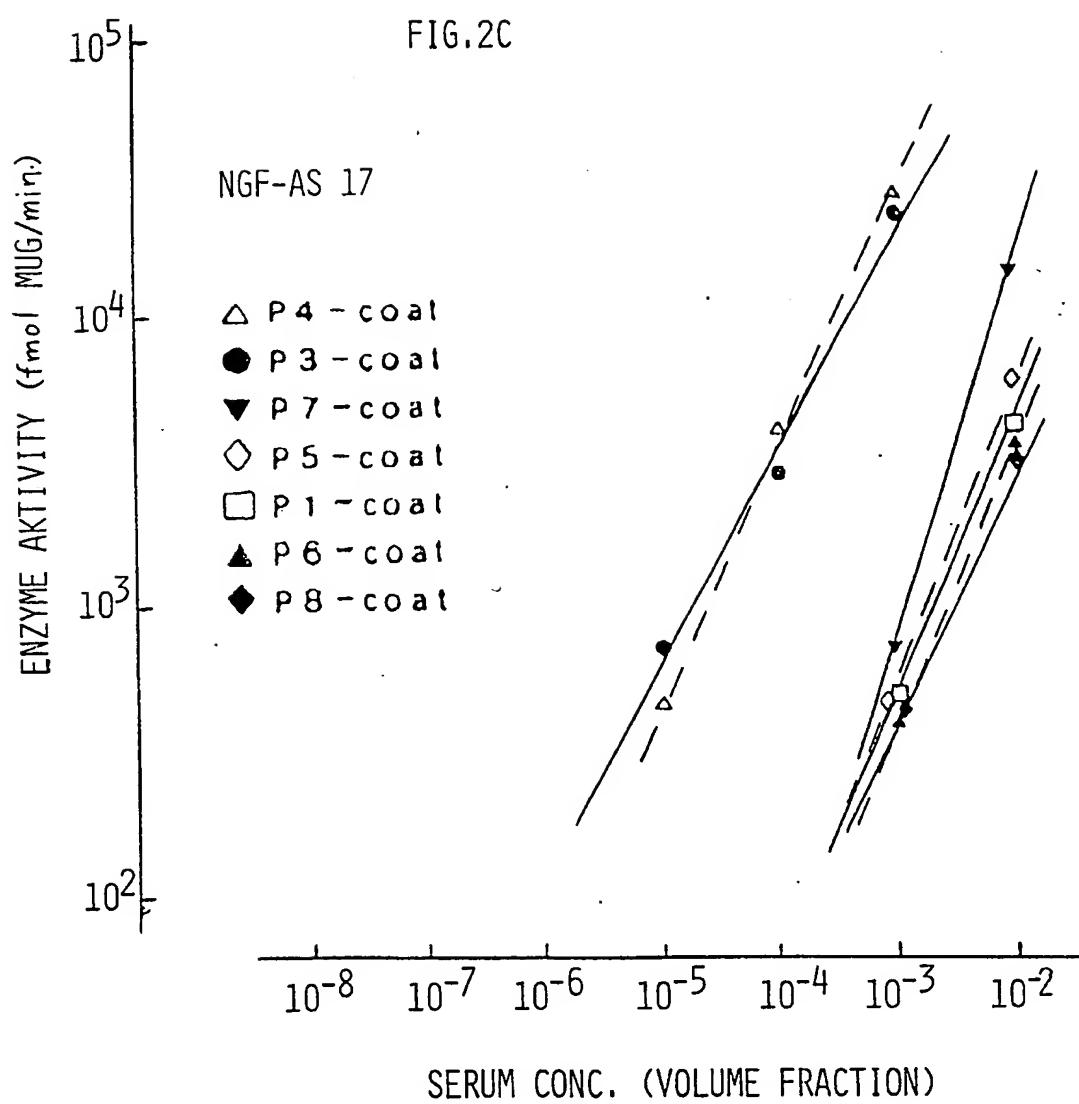
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FIG.2B

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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00149

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁵

According to International Patent Classification (IPC) or to both National Classification and IPC
IPC5: C 07 K 7/08, G 01 N 33/53

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols
IPC5	C 07 K; G 01 N
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched ⁸	

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	METHODS IN ENZYMOLOGY, Vol. 147, 1987 Sigrun Korschning et al: "Two-Site Enzyme Immunoassay for Nerve Growth Factor", see page 167 - page ff	8,9
Y	THE EMBO JOURNAL, Vol. 5, No. 7, 1986 R. Meier et al: "Molecular cloning of bovine and chick nerve growth factor (NGF): delineation of conserved and unconserved domains and their relationship to the biological activity and antigenicity of NGF", see page 1489 - page 1493 see in particular fig 3 and pages 1491-2	1-7,10-14
	--	1-14

* Special categories of cited documents:¹⁰

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13th June 1990	1990-06-20
International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer <i>Carl-Olof Gustafsson</i> Carl-Olof Gustafsson

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		Relevant to Claim No
Category	Citation of Document, with indication, where appropriate, of the relevant passages	
Y	JOURNAL OF NEUROSCIENCE RESEARCH, Vol. 22, 1989 E. Dicou et al: "Synthesis of Chimeric Mouse Nerve Growth Factor Precursor and Human B-Nerve Growth Factor in Escherichia coli: Immunological Properties ", see page 13 - page 19 see in particular page 18 --	1-14
Y	THE EMBO JOURNAL, Vol. 5, No. 7, 1986 Ted Ebendal et al: "Structure and expression of the chicken B nerve growth factor gene ", see page 1483 - page 1487 see in particular fig 3 and page 1486 --	1-14
X	METHODS IN ENZYMOLOGY, Vol. 147, 1987 Kenneth E. Neet et al: "Derivation of Monoclonal Antibody to Nerve Growth Factor ", see page 186 - page ff --	8,10
P,X	JOURNAL OF NEUROSCIENCE RESEARCH, Vol. 22, No. 3, 1989 T. Ebendal et al: "Characterization of Antibodies to Synthetic Nerve Growth Factor (NGF) and ProNGF Peptides ", see page 223 - page 240 --	1-14
P,X	Chemical Abstracts, volume 111, no. 23, 4 December 1989, (Columbus, Ohio, US), Dicou, Eleni : "Interaction of antibodies to synthetic peptides of proNGF with in vitro synthesized NGF precursors ", see page 125, abstract 209702k, & FEBS Lett 1989, 255(2), 215- 218K --	1,2,6,8-10
P,X	WO, A1, 8909225 (THE REGENTS OF THE UNIVERSITY OF CALIFORNIA) 5 October 1989, see pages 14-22 and claims -----	1,3

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 90/00149

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Patent document cited in search report	Publication date		Patent family member(s)	Publication date
WO-A1- 8909225	89-10-05		AU-D- EP-A- 3418389 0335637	89-10-16 89-10-04

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